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AAIA

Air Accident Investigation Authority

Abnormal Runway Contact (ARC)

Serious Incident Investigation

Final Report

Boeing 747-47UF

Hong Kong International Airport

Hong Kong

30 August 2018

03-2020

Reader Advisory Information

Safety Investigations

The objective of a safety investigation is to identify and reduce safety-related risk.

The Air Accident Investigation Authority (AAIA) investigations determine and communicate the factors related to transport safety occurrences under investigation.

It is not a function of the AAIA to apportion blame or determine liability, while at the same time an investigation report must also include the factual material of sufficient weight to support the analysis, findings, and safety recommendations.

At all times the AAIA endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, how and why, in a fair and unbiased manner.

This serious incident investigation final report contains information of an occurrence involving a Boeing 747-47UF aircraft, registration N415MC, operated by Atlas Air (GTI), which occurred on 30 August 2018.

The information contained in this final report is to inform the aviation industry and the travelling public of the general circumstances of the serious incident. This factual report supersedes all previous Preliminary report and Interim statements concerning this serious incident investigation.

The National Transportation Safety Board of the United States of America (NTSB), the Boeing Company, and the aircraft operator assisted the Investigator-in-charge (IIC).

As serious incident investigation reports are public documents, this is a reader advisory to assist with the interpretation of the information for the public and to assist with following the sequence and chain of events covered in the factual information of the serious incident flight.

The chronology and event timeline concerning the history of the flight is linear. To assist with understanding the complex lines of information the descriptive text is supplemented where relevant with images, diagrams, and/or maps indicating the flight path and various critical or key information on the serious incident timeline with a reference to a map position, diagram or component location.

Conduct of the investigation was in accordance with Annex 13 to the Convention on International Civil Aviation and the Hong Kong Civil Aviation (Investigation of Accidents) Regulations (Cap. 448B).

The Air Accident Investigation Authority has compiled this report for the sole purpose of improving aviation safety.

Having established all of the relevant factors, this serious incident investigation final report will advise of the safety recommendations intended to prevent a reoccurrence.

The sole objective of the investigation of this serious incident is the prevention of accidents and incidents. It is not the purpose or intent of this safety investigation report to apportion blame or liability.

Chief Accident and Safety Investigator

Air Accident Investigation Authority

Hong Kong

Synopsis

On 30 August 2018, the Atlas Air Boeing 747-47UF aircraft, registration N415MC, flight number GTI 8086, operated from Al Maktoum International Airport, Dubai (OMDW) to Hong Kong International Airport (VHHH).

Shortly after touchdown on Runway 25R, the aircraft firstly veered to the right and then to the left of the runway centreline. About five seconds later, it reversed abruptly towards the runway centreline.

As the aircraft veered to the right, the aircraft also rolled, so that the bottom of No.3 and No.4 engine nacelles made contact with the runway before the aircraft was realigned with the runway centreline. The lower section of the engine nacelles and No.4 engine was damaged. There was no engine fire and abnormal indications on the engine instruments. The aircraft taxied on to a cargo parking stand.

The investigation identified that the damage to the underside of the inlet cowl, fan cowl and reverser translating cowl of No.3 and No.4 engines was due to the combined effects of a sharp right yaw and significant right roll corresponding to the exaggerated inputs to the flight controls made by the pilot flying.

The investigation team has made one safety recommendation.

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1. FACTUAL INFORMATION

1.1. History of the Flight

On 30 August 2018, an Atlas Air Boeing 747-47UF freighter, flight number GTI 8086, registration N415MC, operated from Al Maktoum International Airport, Dubai (OMDW) to Hong Kong International Airport (VHHH). The flight time was about 8 hours and 12 minutes.

The Pilot Flying (PF), who occupied the left-hand seat, was undergoing a line check. Prior to Top of Descent, the Pilot Monitoring (PM) in the right-hand seat was the Line Check Captain. Behind them were two non-flying aircrew occupying the observers' stations inside the flight deck.

At touchdown on Runway 25R at 1153 hrs local time, the aircraft firstly veered to the right of the runway centreline, then reversed abruptly to the left of the centreline, and sharply banked to the right of the centreline again. The right bank caused the right wing to drop so low that the bottom of No.3 and No.4 engine cowlings contacted the runway.

The aircraft eventually realigned with the runway centreline and taxied to the cargo parking apron.

1.2. Injuries to Persons

The persons on board included four crewmembers and one passenger. The crewmembers comprised one Captain (CA), one Line Check-Airman (LCA), one Relief First Officer (RFO) and one dead heading Operational Experience First Officer (OE FO). The passenger was a company mechanic. There was no injury to any person involved in the flight or to any third party.

Injuries to Persons						
Persons on board:	Crew	4	Passengers	1	Others	0
Injuries	Crew	0	Passengers	0		

Table 1: Injuries to Persons

1.3. Damage - Aircraft

The aircraft suffered minor damage on the No.3 and No.4 engine nacelles and adjacent components. The details are included in Section 1.12.

Photo 1: Damage at the Underside of No.3 Engine

Photo 2: Damage at the Underside of No.4 Engine

1.4. Other Damages

There was no other damage to objects other than the No.3 and No.4 engines.

1.5. Personnel Information

1.5.1. Flight Crew

The CA and the LCA were the PF and the PM respectively on final approach. They held valid licences and medical certificates.

The crew information is in Section 6.2.

1.6. Aircraft Information

1.6.1. Aircraft

The Boeing 747-47UF aircraft, serial number 32837, was delivered to Atlas Air in May 2002. It is the freighter version of 747-400 and has a four-engine wide-body layout and a two-crew

glass cockpit. It is a low-winged transport aircraft with four GE CF6-80 series turbo-fan engines pylon-mounted below and forward of the wing leading edges. The wingspan is 64.9 m (213 ft) at maximum gross weight and the overall length is 68.6 m (225 ft). The engines are numbered from left to right, as Nos. 1 to 4. The fan duct portion of each engine consists of, from front to rear, an inlet cowl, a fan cowl and a reverser translating cowl. The aircraft details are in Section 6.3.

The vertical clearance from the ground of No.3 engine is from 0.71 m (2 ft 3 in) to 0.93 m (3 ft). For No.4 engine, the vertical clearance is from 1.32 m (4 ft 4 in) to 1.8 m (5 ft 10 in).

1.6.2. Aircraft Loading

The aircraft was ferried to VHHH and the recorded gross weight at landing was 418,240 pounds (The maximum landing weight was 630,000 pounds).

1.6.3. Maintenance History

The last C check was carried out on 12 February 2018 (total 62,699 airframe hours and 10,732 cycles). The time since this C check was 4,577 hrs/840 cycles.

There were two Interval C Minimum Equipment List (MEL) items[1] recorded before the departure flight.

1.7. Meteorological Factors

1.7.1. METAR

The meteorological aerodrome weather report (METAR) for VHHH at 1130 hours indicated that the wind direction was from 180 degrees with variation from 150 degrees to 220 degrees. The wind speed was at 17 knots gusting to 28 knots. The visibility was 10 kilometres or above. There were few clouds at 1000 feet above sea level and scattered clouds at 2300 feet. The air temperature was 29 degree Celsius and the dew point was 25 degree Celsius. There were no significant differences in the METAR at 1200 hours.

The Automatic Terminal Information Service (ATIS) at 1137 hours forecast that there could be significant windshear and moderate turbulence on Runway 25R. The wind was from 190 degrees at 18 knots.

[1] An inoperative item which shall be repaired within 10 consecutive calendar days, excluding the day of discovery.

1.7.2. ATIS

The wind data of the touchdown zone on Runway 25R on the incident day was as follows.

Time	2-min mean wind direction (degree)	2-min mean wind speed (knot)	10-min gust (knot)
11:50:00	159	12	25
11:51:00	151	10	25
11:52:00	153	13	25
11:53:00	148	12	25
11:54:00	154	13	25
11:55:00	171	17	30
11:56:00	184	18	30
11:57:00	182	17	30
11:58:00	182	15	30
11:59:00	188	14	30
12:00:00	180	15	30

Table 2: Wind Data of the Touchdown Zone on Runway 25R

1.8. Navigation Aids

The Hong Kong International Airport has two runways and is equipped with NDB, DVOR, DME, LOC, ILS CAT-I, CAT-II, CAT-IIIA, GP, A-SMGCS and SMR. There were no reported difficulties with navigational aids at the Airport.

1.9. Communications

The aircraft was equipped with VHF radio communication systems. All VHF radios were serviceable. All communications between Hong Kong ATC and the crew were recorded by Voice Recording System in the ATC System.

1.10. Aerodrome Information

The information on the departure and the destination aerodromes is listed in Section 6.4.

1.11. Flight Recorders

The aircraft was equipped with a Honeywell 980-4700 solid-state FDR mounted in the aircraft's aft equipment area, and a Honeywell 980-6022 CVR capable of recording and retaining 2 hours of audio information. The CVR records the flight crew voices from the audio control panels and other sounds inside the flight compartment via the flight compartment area microphone.

Both recorders were undamaged and recordings were successfully recovered from them. The CVR recordings indicated that throughout the flight the crew were communicating fully with each other, discussing the situation and observing procedures, briefings and checklists in a professional manner.

A time history of relevant FDR parameters for the final approach and landing roll is shown in Appendix 9.1. It can be seen that, up to about 10 seconds before touchdown, the recorded

wind direction was generally from the south (actual direction about 200°), with a wind speed that varied from about 17 to 20 knots.

The descent rate was maintained primarily at an average of around 900 feet/minute (fpm) until just prior to flare initiation, with a momentary excursion to 330 fpm and 1320 fpm at 450 feet radio altitude. The aircraft was crabbed (negative drift) into the left crosswind with an angle of about 7 degrees during the approach.

1.12. Wreckage and Impact

The underside of the inlet cow, fan cowl, and reverser translating cowl of No.3 and No.4 engines sustained scrapping and abrasion damage. The drain masts of both engines suffered heavy abrasion damage. The damaged parts on No.3 engine and No.4 engine were replaced.

1.13. Medical/Pathological Information

No medical or pathological investigations were conducted as a result of this occurrence, nor were they required.

1.14. Smoke, Fire, and Fumes

There was no fire damage on the aircraft.

1.15. Survival Aspects

No search and evacuation were required as a result of this occurrence.

1.16. Tests and Research

There were no specific tests and research done in this investigation.

1.17. Organisational and Management Information System Safety

1.17.1. Atlas Air

Atlas Air, Inc. a USA airline operating cargo and passenger transportation services. It is the world's largest operator of Boeing 747 aircraft.

1.17.2. The Boeing Company

The Boeing Company (Boeing) is the type certificate holder and the manufacturer of 747-400 series aircraft.

1.18. Additional Information

1.18.1. Choice of Crosswind Landing Techniques

There are various techniques for landing in crosswinds.

The priority of these techniques is to maintain the runway heading for the stabilised approach and correct for the directional change of the aircraft during the flare or after touchdown (Weight on Wheels).

As no two crosswind landings are the same, the operator can specify a preferred technique or type of crosswind landing technique which can be agreed at the Top of Descent (ToD) briefing.

A pilot handling an aircraft for the arrival and landing is responsible for choosing the appropriate landing technique which he thinks fit.

1.18.2. Boeing 747 Flight Crew Training Manual (FCTM)[2]

The FCTM contains the following recommendations that are applicable to this event:

1.18.2.1. Landing Crosswind Guidelines

Crosswind guidelines are not considered limitations. Crosswind guidelines are provided to assist operators in establishing their crosswind policies.

On slippery runways, crosswind guidelines are a function of runway surface condition. These guidelines assume adverse (i.e. asymmetric) airplane loading and proper piloting techniques.

1.18.2.2. Crosswind Landing Techniques

Three methods of performing crosswind landings are presented. They are the de-crab technique (with removal of crab in flare), touchdown in a crab, and the sideslip technique.

Whenever a crab is maintained during a crosswind approach, offset the flight deck on the upwind side of centreline so that the main gear touches down in the centre of the runway.

1.18.2.3. De-Crab During Flare

The objective of this technique is to maintain wings level throughout the approach, flare, and touchdown. On final approach, a crab angle is established with wings level to maintain the desired track. Just prior to touchdown while flaring the airplane, downwind rudder is applied to eliminate the crab and align the airplane with the runway centreline.

As rudder is applied, the upwind wing sweeps forward developing roll. Hold wings level with simultaneous application of aileron control into the wind. The touchdown is made with cross controls and both gear touching down simultaneously. Throughout the touchdown phase upwind aileron application is utilized to keep the wings level.

1.18.2.4. Touchdown in Crab

The airplane can land using crab only (zero sideslip) up to the landing crosswind guideline speeds.[3]

On dry runways, upon touchdown the airplane tracks toward the upwind edge of the runway while de-crabbing to align with the runway. Immediate upwind aileron is needed to ensure the wings remain level while rudder is needed to track the runway centreline. The greater the amount of crab at touchdown, the larger the lateral deviation from the point of touchdown. For this reason, touchdown in a crab only condition is not recommended when landing on a dry runway in strong crosswinds.

On very slippery runways, landing the airplane using crab only reduces drift toward the downwind side at touchdown, permits rapid operation of spoilers and autobrakes because all main gears touchdown simultaneously, and may reduce pilot workload since the airplane does not have to be de-crabbed before touchdown. However, proper rudder and upwind aileron must be applied after touchdown to ensure directional control is maintained.

1.18.2.5. Sideslip (Wing Low)

The sideslip crosswind technique aligns the airplane with the extended runway centreline so that main gear touchdown occurs on the runway centreline.

1.18.2.6. Airspeed Control

The FCTM contains the following recommendations that are applicable to this event:

If the autothrottle is disconnected, or is planned to be disconnected prior to landing, maintain reference speed plus any wind additive until approaching the flare. Minimum command

[2] The Flight Crew Training Manual provides information and recommendations on manoeuvres and techniques.

[3] A landing crosswind guidelines speed table is contained in the FCTM.

speed setting is VREF + 5 knots. With proper flare technique and thrust management the 5 knots additive and some of the steady wind additive may be bled off prior to touchdown. It should be planned to maintain gust correction until touchdown. Touchdown should occur at no less than VREF - 5 knots.

1.18.3. Atlas Air Guidance on Landing Techniques

During the internal interview, the PF was able to discuss the various approach techniques but not how they applied in practice or the pros and cons of each.

A review of available documentation showed the only published guidance on proper landing technique for the 747-400 in crosswind or otherwise is the FCTM. The PF stated he had not reviewed the FCTM recently. The FCTM is currently for reference only and not required at any point during training.

The Flight Crew Operating Manual (FCOM) at the time of the occurrence did not contain any guidance other than the operator's company procedure during landing.

1.18.4. Closed-circuit Television (CCTV) Captures

The landing was captured by various CCTV cameras facing the directions of 07L and 25R at the runway.

Photo 3: Aircraft Banking to the Left (Looking from 07L Direction)

Photo 4: Aircraft Banking to the Left (Looking from 25R Direction)

Photo 5: Aircraft Banking to the Right (Looking from 25R Direction)

Photo 6: Aircraft Banking to the Right (Looking from 07L Direction)

Photo 7: Veering to the Right, Left Wing High (Looking from 25R Direction)

Photo 8: Aircraft Returning to Normal Attitude (Looking from 25R Direction)

1.18.5. Animation Screen Captures

The flight data was analysed and the animation was produced. The screen captures below indicated the rudder and ailerons input after touchdown.

Figure 1: Aircraft in a Crab at Touchdown

Figure 2: Full Right Rudder Applied

Figure 3: Full Left Rudder Applied

Figure 3 showed that the aircraft was on the centreline with ailerons neutral and full left rudder applied.

Figure 4: Full Right Aileron Applied

The aircraft was at approximately 30 degrees to the left of the centreline with the control column at full right deflection and full right rudder applied.

1.18.5.1. Aircraft Direction Control with Weight on Wheels (WoW).

Aircraft direction control following the transition to WoW is unilateral, and controlled at high speeds (typically above 30 knots) by the use of the aircraft rudder control.

At speeds below 30 knots the nose wheel steering control is used, occasionally with the use of differential braking if required.

Aircraft directional control with the use of the ailerons is not an approved direction control process on the ground.

1.19. Useful or Effective Investigation Techniques

Not applicable in this investigation.

2. Safety Analysis

The Safety Analysis provides a detailed discussion of the safety factors identified during the investigation, providing the evidence required to support the findings, contributing factors and the safety recommendations.

2.1. Introduction

Prior to touchdown, the descent rate was maintained primarily at an average of around 900 feet per minute (fpm) until just prior to flare initiation, with a momentary excursion to 330 fpm and 1320 fpm at 450 feet radio altitude. The aircraft was crabbed (negative drift) into the left crosswind with an angle of about 7 degrees during the approach.

2.2. Weather

The analysis of recorded flight data indicated that there was no windshear or other EGPWS warning at the time of touchdown. The wind direction and the wind speed captured in the flight data was 200 degrees (50 degrees from the left of the runway centreline) and 17 knot. However, the wind direction was only recorded once every 4 seconds, which is inadequate for analysis of the prevailing wind conditions.

According to the wind data of the touchdown zone on Runway 25R, between 1154 hours and 1155 hours, the wind direction was between 154 degrees and 171 degrees. The wind speed was between 13 knots and 17 knots, gusting between 25 knots and 30 knots. It was believed that this was the wind condition the aircraft experienced at touchdown.

2.3. Flight Operations

2.3.1. Flight Data Analysis

The analysis of the FDR data indicated that the aircraft systems functioned per design. No system anomalies were observed.

The take-off and the cruise portions of the flight had no issues and were conducted per the operator's company procedures. There were no complications encountered during the flight.

The FDR data showed the controls positioned at neutral at the beginning of the flare, then a few seconds into flare the rudder pedal initially deflected upwind (left), then downwind (right), with control wheel deflected abruptly into the wind (left), then varied to the right and again left prior to touchdown. A 6-degree crab angle was present at touchdown.

At touchdown, right pedal and right roll inputs were made. The aircraft yawed right to 255 degrees (magnetic heading), 5 degrees to the right of the runway centreline, and made a right roll of up to 3.2°. This attitude lasted for about 2 seconds.

Then substantial left pedal and left roll inputs were made, seemingly checking the momentarily right bank. However, these inputs were exaggerated and the aircraft turned left a heading of 236 degrees (14 degrees to the left of the runway centreline) and a left roll of about 4.6 degrees. This moment lasted for about 5 seconds.

Two seconds before reaching the heading of 236 degrees, substantial right pedal and right roll inputs were made, again seemingly checking the significant left bank. The inputs took effect and the aircraft bank to the right. When the aircraft heading reached 245 degrees, it reached the maximum right roll of 5.6 degrees. It was believed that at this point the combined effects of the sharp right yaw and right roll caused a significant drop of the right

wing. As a result, the underside of the inlet cowl, fan cowl and reverser translating cowl of No.3 and No.4 engines heavily abraded the runway and locally deformed.

After that, the attitude of the aircraft eventually returned to normal.

Based on the various weather information, it is considered that wind direction and speed was not a significant issue to the control of the aircraft during and after landing.

From the recorded data, it is clear that the aircraft responded correctly to the crew's control inputs.

The aircraft veering and rolling was probably due to a series of incorrect rudder and aileron inputs made after the touchdown.

2.3.2. Boeing's Analysis

Boeing indicated that the 747-400 FCTM included the Flight Safety Foundation's (FSF) published criteria for flying a stabilized approach. These criteria recommend that a go-around should be initiated if the approach becomes unstabilized under 1000 feet above the ground for instrument meteorological conditions (IMC) and under 500 feet for visual meteorological conditions (VMC).

The data showed that the approach was outside the guidelines of a stabilized approach with an unsteady vertical speed, excessive airspeed, and excessive manoeuvring in an attempt to maintain the desired flight path. Below 500 feet radio altitude, the airplane did not adhere to three of the recommended stabilized approach criteria. These criteria are summarized as follows.

- only small changes in heading and pitch are required to maintain the correct flight path
- the airplane should be at approach speed. Deviations of +10 knots to -5 knots are acceptable if the airspeed is trending toward approach speed
- sink rate is no greater than 1,000 fpm; if an approach requires a sink rate greater than 1,000 fpm, a special briefing should be conducted

After touchdown, large and dynamic control inputs through the rudder pedal and control wheel caused the aircraft to deviate from wings level and veer away from the runway heading. At one point, about 10 seconds after touchdown, the commanded inputs reached full deflection in the same direction, which contributed to the development of the right bank angle and led to the nacelle strike. The bank angle after touchdown reached 4.6 degrees to the left, then abruptly transitioned to 5.6 degrees to the right due to the control inputs, a change of 10.2 degrees with a roll rate of 10 degrees/second. Ground contact of the No.3 and No.4 engine nacelles most likely occurred approximately 10 seconds after touchdown as the maximum right bank angle was reached. A go-around would have been warranted as soon as the stabilized approach criteria were exceeded.

2.3.3. Atlas Air's Analysis

Atlas Air also conducted an internal investigation of this event. The PF and the RFO flew the departure from OMDW with no issues. The LCA observed the departure and crew coordination as part of the PF's ALC. At the Top of Climb, the LCA excused himself from the flight deck and began his scheduled rest period. Prior to the Top of Descent the PF conducted an approach briefing with all pilots present, including the weather, planned runway, possible threats, and performance considerations – they were in a light aeroplane so performance during a Go-Around, if needed, would require extra attention. The PF's briefing was followed by referencing the Quick Reference Handbook (QRH) briefing guide to cover any missed items.

The approach was flown manually by the PF following the Flight Director with no issues. The PF had a constant crab angle during the descent on final approach. On short final the PM (the LCA) noted they were a little high on profile but still within the landing limits. As the

aircraft descended through 50 ft radio altitude and the flare began, the PM noticed they were still in a crab. He verbalized, bring the nose over [to the left and centreline].

After touchdown, the PF was most likely reacting to the evolving situation as it was happening; the PM was trying to regain control of the situation. The aircraft then abruptly veered right, the right wing lowered and most likely both engine pods of No.3 and No.4 engines contacted the runway as the aircraft turned towards the centreline. The event lasted for approximately 16 seconds.

The crew regained centreline as the aircraft began to decelerate below 90 knots. The aircraft taxied to the parking bay with no issues.

2.3.4. AAIA's Analysis

2.3.4.1. Dynamic Interaction of the Ground Loads and Aerodynamics Loads

The aircraft was in a crab at touchdown and the left wing lifted because of the crosswind. Due to the landing gear mass distribution, there were compound effects of the runway friction induced moments around the gear and acting on the lateral control inputs. According to the analysis of the flight data, the pilot's input on the controls was about 2 seconds behind the directional control of the aircraft.

Each input was for the previous lateral deviation and the pilot at one point over-corrected with full LH rudder deflection as the aircraft yawed left.

It is possible that the PF was unfamiliar with the techniques of de-crabbing an aircraft just before touchdown in crosswind landing.

2.4. Human Factors

2.4.1. Fatigue

The PF did not take rest after the aircraft took off from OMDW. Prior to the Top of Descent the line check captain returned to the flight deck to relieve the PF for rest. The PF stated that he did not need rest and was good to continue flying. The RFO then decided he would take rest and was relieved of duty. The flying crew was then the PF and the LCA as PM.

When the PF was questioned why he did not take rest, he advised that he was chatting with the Operational Experience (OE) student and RFO and did not feel as though he was tired or needed the rest. The PF also stated he felt when he did take rest, it often contributed to him becoming ill or catching a virus. The PF did not want to become ill or sick following the flight. Atlas Air had never heard this excuse or received any reports to indicate this was a problem (from the PF or any other crewmember) prior to the PF's interview.

2.4.2. Crew Resources Management

Prior to Top of Descent, the PF and the PM did not discuss crosswind landing technique or what would be expected during landing. The PF had mentally prepared to touch down in a crab. The PF stated that he normally utilizes "the European Method" which is touching down in a crab. He learned the technique when he worked with a European operator. Landing in a crab was his preferred crosswind technique and what he utilized on a regular basis.

After the line check captain verbalized, bring the nose over [to the left and centreline], the PF recognised this was his Annual Line Check (ALC) and realized the line check captain wanted or was expecting him to de-crab prior to touchdown. The PF followed the line check captain's prompt and tried to align the nose with the centreline. The sudden change in the PF's landing method most likely contributed to the aircraft float during the flare manoeuvre. As the aircraft floated it began to drift downwind and left of runway centreline.

During the Atlas Air interviews, the line check captain indicated he assumed an experienced captain would not have any trouble landing with the reported conditions. Also, the PM

assumed the PF would utilize the preferred crosswind method of Crab to De-crab in the Boeing FCTM (See 1.18.2).

3. Conclusions

3.1. Findings

3.1.1 The flight crewmembers were licensed and qualified for the flight in accordance with existing regulations.

3.1.2 The aircraft was airworthy when dispatched for the flight.

3.1.3 There was no evidence of airframe failure or system malfunction known prior to the incident.

3.1.4 The maintenance records indicated that the aircraft was equipped and maintained in accordance with existing regulations and approved procedures.

3.1.5 The damage to the underside of No.3 and No.4 engines was due to excessive dropping of the right wing as a result of the PF's input.

3.1.6 Prior to Top of Descent, the PF and the PM did not discuss crosswind landing technique or what would be expected during landing.

3.1.7 The PF had mentally prepared to touch down in a crab which was his preferred crosswind technique.

3.1.8 The PF later realized the line check captain expected him to de-crab prior to touchdown. The PF tried to align the nose with the centreline and made a sudden change in the landing method.

3.1.9 The line check captain assumed an experienced captain would not have any trouble landing with the reported conditions, and the PF would utilize the preferred crosswind method of Crab to De-crab in the Boeing FCTM.

3.2. Causes

The damage to the underside of the inlet cowl, fan cowl and translating cowl of No.3 and No.4 engines was due to the combined effects of a sharp right yaw and significant right roll corresponding to the exaggerated inputs made by the PF.

3.3. Contributing Factors

3.3.1 The PF made a sudden change of his crosswind landing technique from crab to de-crab before the short final because he considered that the line check captain expected a de-crab landing.

3.3.2 Prior to Top of Descent, the PF and the PM did not discuss crosswind landing technique or what would be expected during landing.

4. Safety Recommendations

4.1. Safety Recommendation 07-2020

It is recommended that the aircraft operator reviews the Crew Resource Management (CRM) in the annual line checks.

Safety Recommendation Owner: Atlas Air

5. Additional Safety Issues

Whether or not the AAIA identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk.

The AAIA has been advised of the following proactive safety action in response to this occurrence.

5.1. Safety Actions Already Implemented by Atlas Air

5.1.1. Re-train of the PF

The PF failed the line check and was required to complete additional training, including a ground-based training session on various crosswind performance items and techniques, a full-flight simulator session to include crosswind landings of varying directions and intensities. He was also required to successfully complete an administrative Line Check in addition to the ALC conducted within six months of the ALC.

5.1.2. Development of Crosswind Operations Training

The Flight Operations Department was recommended to develop a ground school module on crosswind operations (takeoff and landings) to include preferred techniques, flight control inputs, performance considerations, application of reverse thrust, effects of the side thrust component if applicable for all aircraft types.

- Module should be demonstrated and explained to all Instructors and Line Check Airmen.
- Ensure standardization of all Instructors and Line Check Airmen to correct procedures and techniques during crosswind conditions.
- Module should be presented to all crewmembers at Initial, Transition and Upgrade training prior to full flight simulators (FFS).

5.1.3. Revision of the FFS Modules

In addition, the Flight Operations Department was recommended to revise the FFS modules to incorporate a realistic amount of crosswind component for all takeoffs and landings pursuant to Extended Envelope and Adverse Weather Training of 14 CFR Part 60. Multiple FFS modules should contain multiple different crosswind component scenarios and crosswind component scenarios should be of varying directions and intensities.

5.1.4. Ensuring Reading of FCTM

The Flight Operations Department was recommended to ensure Initial, Transition and Upgrade curriculums make reading of the FCTM compulsory prior to FFS, update fleet specific curriculums as necessary.

6. General Details

6.1. Occurrence Details

Date and time:	30 August 2018, 1153 hours (local time)	
Occurrence category:	Serious Incident	
Primary occurrence type:	Abnormal Runway Contact (ARC)	
Location:	Runway 25R, Hong Kong International Airport, Hong Kong	
	Latitude: 22°18'57.69"N	Longitude: 113°54'48.82"E

6.2. Pilot Information

6.2.1. Pilot-in-Command

Age:	52 years
Licence:	FAA Airline Transport Pilot (ATP) certificate
Aircraft ratings:	Boeing 737 and 747-4
Date of first issue of aircraft rating on type:	February, 2008
Instrument rating:	Yes
Medical certificate:	FAA First Class
Date of last proficiency check on type:	September 2017
Date of last line check on type:	September 2017
Date of last emergency drills check:	September 2017
ICAO Language Proficiency:	English Proficient
Limitation:	None
Flying Experience:	
Total all types:	5,223 hours Company Time
Total on type (747-400) :	5,200 hours Company Time
Total in last 90 days:	207 hours Company Time
Total in last 30 days :	92 hours Company Time
Total in last 7 days:	20 hours Company Time
Total in last 24 hours:	10 hours Company Time
Duty Time:	
Day up to the incident flight (Hours:Mins) :	14 hours 8 minutes
Day prior to incident (Hours:Mins) :	0 hours 0 minutes

6.2.2. Line Check Captain (Pilot Monitoring)

Age:	58 years
Licence:	FAA Airline Transport Pilot (ATP) certificate
Aircraft ratings:	Boeing 747 and 747-4.
Date of first issue of aircraft rating on type:	February 2008
Instrument rating:	Yes
Medical certificate:	FAA First Class
Date of last proficiency check on type:	September 2017
Date of last line check on type:	October 2017
Date of last emergency drills check:	September 2017
ICAO Language Proficiency:	English Proficient
Limitation:	None
Flying Experience:	
Total all types:	16,000 hours Company Time
Total on type (747-400) :	7,600 hours Company Time
Total in last 90 days:	172 hours Company Time
Total in last 30 days :	71 hours Company Time
Total in last 7 days:	25 hours Company Time
Total in last 24 hours:	18 hours Company Time
Duty Time:	
Day up to the incident flight (Hours:Mins) :	9 hours 28 minutes
Day prior to incident (Hours:Mins) :	13 hours 30 minutes

6.3. Aircraft Details

Manufacturer and model:	Boeing 747-47UF	
Registration:	USA, N415MC	
Aircraft Serial number:	32837	
Year of Manufacture	2002	
Engine	Four General Electric CF6-80	
Operator:	Atlas Air (5Y)	
Type of Operation:	Commercial Air Transport (Cargo)	
Certificate of Airworthiness	Issued on 1 May 2002 by the FAA, Standard Airworthiness Certificate	
Departure:	Al Maktoum International Airport	
Destination:	Hong Kong International Airport	
Maximum Take-off Weight	875,000 lbs	
Total Airframe Hours	64,660 hours 45 minutes	
Total Airframe Cycles	11,117 cycles	
Persons on board:	Crew – 4	Passengers – 1
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Minor Damage	

6.4. Aerodrome Information

6.4.1. Aerodrome of Departure

Aerodrome Code	OMDW
Airport Name	Al Maktoum International Airport
Airport Address	Jebel Ali, United Arab Emirates
Airport Authority	Dubai Airports Company
Air Navigation Services	Approach Control, Aerodrome Control, Ground Movement Control, Zone Control, Flight Information Service, Clearance Delivery Control, Automatic Terminal Information Service
Type of Traffic Permitted	IFR/VFR
Coordinates	24°53’17.80”N 55°9’37.36” E
Elevation	171 ft
Runway Length	4500 m
Runway Width	60 m
Stopway	197 ft
Azimuth	12/30

6.4.2. Aerodrome of Destination

Aerodrome Code	VHHH
Airport Name	Hong Kong International Airport
Airport Address	Chek Lap Kok, Lantau Island
Airport Authority	Airport Authority Hong Kong
Air Navigation Services	Approach Control, Aerodrome Control, Ground Movement Control, Zone Control, Flight Information Service, Clearance Delivery Control, Automatic Terminal Information Service
Type of Traffic Permitted	IFR/VFR
Coordinates	22° 18' 32" N, 113° 54' 53" E
Elevation	28 ft
Runway Length	3,800 m
Runway Width	60 m
Stopway	Nil
Runway End Safety Area	240 m x 150 m
Azimuth	07L / 25R, 07R/ 25L
Category for Rescue and Fire Fighting Services	CAT 10

7. Abbreviations

ALC	Annual Line Check
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
CA	Captain
CCTV	Closed-circuit television
CFR	Code of Federal Regulations
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
EGPWS	Enhanced Ground Proximity Warning System
FAA	Federal Aviation Administration
FCOM	Flight Crew Operating Manual
FCTM	Flight Crew Training Manual
FDR	Flight Data Recorder
FFS	Full Flight Simulator
fpm	Feet per minute
GE	General Electric
IFR	Instrument flight rules
IIC	Investigator-in-charge
IMC	Instrument meteorological conditions
LCA	Line Check-Airman
MEL	Minimum Equipment List
METAR	Meteorological aerodrome weather report
NTSB	The National Transportation Safety Board of the United States of America
OE FO	Operational Experience First Officer
OMDW	ICAO code of Al Maktoum International Airport
PF	Pilot Flying
PM	Pilot Monitoring
QRH	Quick Reference Handbook
RFO	Relief First Officer
ToD	Top of Descent
UTC	Coordinated Universal Time
VFR	Visual flight rules
VHHH	ICAO code of Hong Kong International Airport

VMC	Visual meteorological conditions
WoW	Weight on Wheels

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9.1. Flight Data

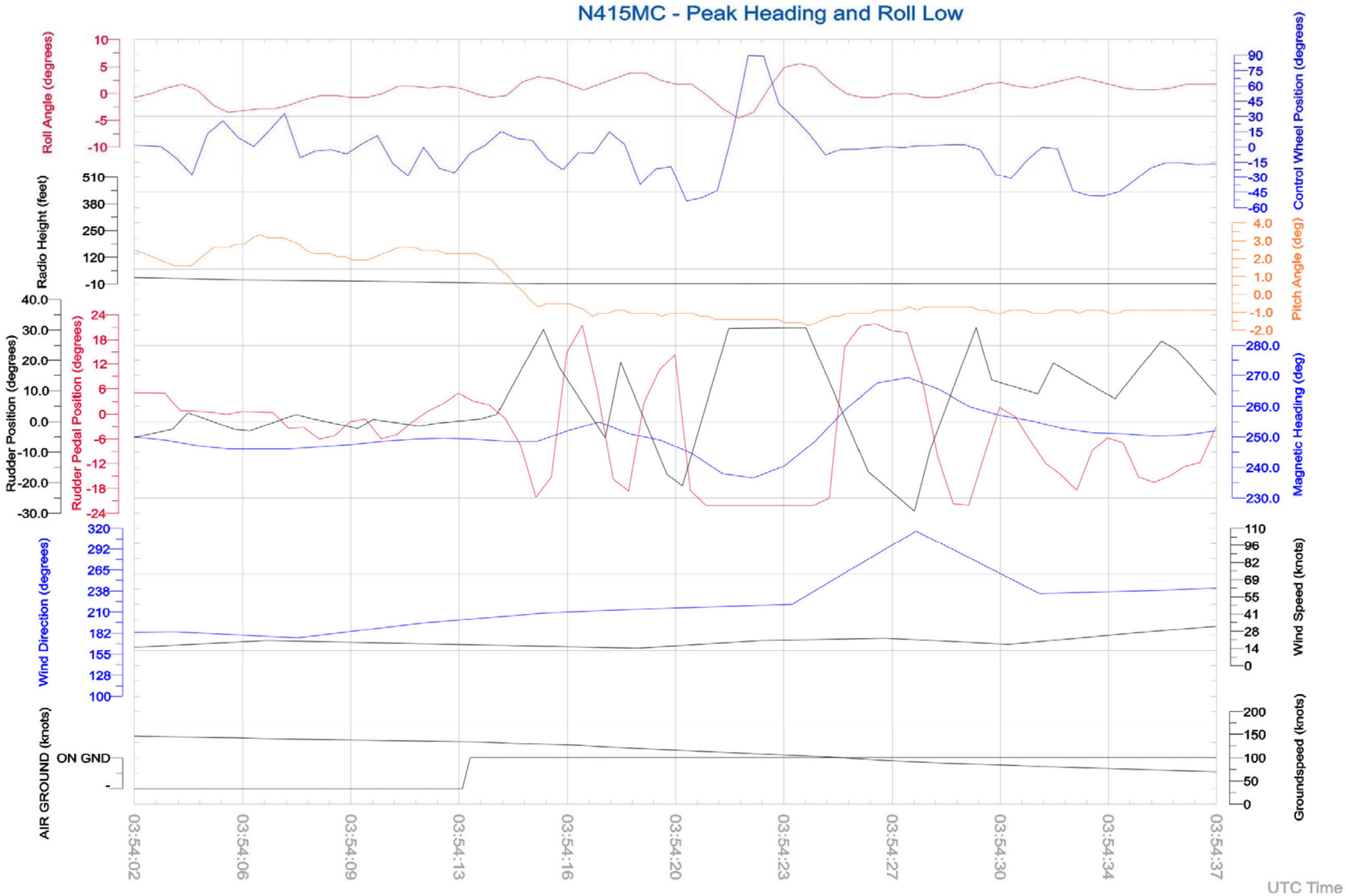

Figure 5: Flight Data Plot of Selected Parameters